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April 24, 1998

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

By Hand Delivery

Ms. Magalie Roman Salas
Secretary
Federal Communications Commission
1919 M Street, N.W. - Room 222
Washington, D.C. 20554

EX PARTE OR LATE FILED

Re: **EX PARTE**
ET Docket 95-18; RM-7927; PP-28

Dear Ms. Salas:

I am submitting to the Federal Communications Commission ("Commission") today in the above-captioned proceeding an equipment survey conducted on behalf of ICO Global Communications ("ICO") that demonstrates the existing availability of digital and RF microwave equipment that can be used for digital electronic news gathering ("ENG") in the 2 GHz spectrum band. I recently distributed the results of this survey to participants attending the 1998 National Association of Broadcasters ("NAB") Conference in Las Vegas.

The attached equipment survey lists manufacturers, models and key features of microwave and digital equipment currently available that will allow providers of broadcast auxiliary services to convert their existing analog ENG equipment to equipment capable of providing digital video transmissions in the 2 GHz frequency band. In addition, a number of equipment vendors at the NAB convention were offering packaged solutions for digital ENG operations, which provides further support for the conclusions reached in my survey that digital and microwave equipment supportive of digital video transmission is readily available. The attached survey has been updated to include available equipment demonstrated at the NAB Conference.

The characteristics of existing digital ENG equipment make operations with 8.5 MHz channels technically feasible. This conclusion is further demonstrated in two recent technical submissions that have been submitted by Nucomm, Inc. and COMSAT in this

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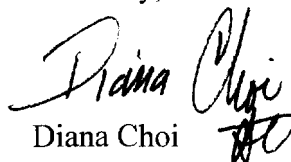
docket, which found that digital video transmissions compressed to 8.5 MHz channels provide quality comparable to current broadcast auxiliary analog transmissions.¹

The equipment survey complements a report that I prepared jointly with a COMSAT engineer entitled, "Increased Spectrum Efficiency Through Digital Video Compression and Transmission," which was submitted to the Commission as a "White Paper" attached to the May 20, 1997 Petition for Partial Reconsideration of the MSS Coalition in this same docket. At the time I prepared the White Paper I was a senior staff engineer in the Data Compression and Digital Multimedia Center at Hughes Telecommunications & Space Company. I subsequently left Hughes and now am consulting for ICO.

Two copies of this letter have been submitted to the Secretary of the Commission for inclusion in the public record, as required by Section 1.1206(b)(1) of the Commission's rules.

Please feel free to call me if you are interested in further details regarding the attached survey.

Sincerely,


Diana Choi

Attachment

cc: Regina Keeney
Thomas Tycz
Rebecca Arbogast
Robert Calaff
Richard Smith
Bruce A. Franca
Sean White
Dan Phythyon
Roy J. Stewart
Keith Larson
Tom Stanley
Dale Hatfield

¹ Ex Parte of Nucomm, Inc., ET Docket No. 95-18, RM-7927, PP-28 (Feb. 11, 1998), "Digital Video Microwave Systems for STL and ENG Applications & Test Results"; Ex Parte of COMSAT Corp., ET Docket No. 95-18, RM-7927, PP-28 (Mar. 18, 1998), "Digital ENG Tests Using Noisecon Microwave Emulator Performed by COMSAT Laboratories, Clarksburg, Maryland."

Digital ENG Equipment Survey Summary

(Revised: April 23, 1998)

Diana Choi

Diana Choi

Diana Choi is currently a consultant for ICO Global Communications. Ms. Choi worked with Hughes Electronics from 1990 to 1997 as a specialist in digital video compression and as a satellite payload systems engineer. She has a B.S. and M.S. in Electrical Engineering from Cornell University in Ithaca, New York.

Introduction

The following is a summary of digital and RF microwave equipment that can be applied to digital broadcast auxiliary service applications, specifically digital electronic news gathering (ENG), in the 2 GHz spectrum band. The digital equipment needed for the conversion from analog to digital ENG transmission consists primarily of digital codecs and modulators. Direct-modulation type transmitters must be replaced by heterodyne-type transmitters.

The digital equipment is readily available and highly configurable to suite a broad range of digital video applications. The digital video compression equipment primarily adopts the MPEG-2 international standard and implements both the main profile 4:2:0 @ main level (MP@ML) and studio profile 4:2:2 @ main level (SP@ML) configurations. Some manufacturers integrate multiple functionalities, such as an analog-to-digital converter, an MPEG-2 encoder, and a digital modulator together into a single hardware unit. Other manufacturers separate those functionalities into individual units to allow for greater flexibility in the overall system design. The greater flexibility provides for greater control of the types of filters, noise reducers, compression encoders, digital modulators used in the transmission system that best suite the needs of the application.

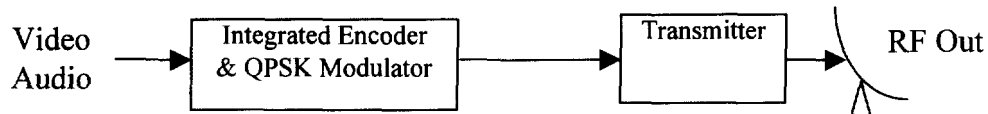
At the recent NAB show in April 1998, microwave manufacturers showed portable digital microwave equipment for ENG. Three microwave manufacturers - California Microwave/Microwave Radio Communications, Nucomm, Continental Microwave/RF Technology – offer system solutions for digital video transmission in the 2 GHz BAS/ENG band. Historically, the majority of current microwave equipment is of the direct-modulation type, which integrates the analog FM modulation and frequency upconversion functions. For digital transmission, the transmitter must be the heterodyne type, which does not modulate / remodulate the signal, since the output from typical digital modems is already a modulated IF signal. In addition, the amplifier must operate in linear mode for digital transmission, whereas the amplifier can operate in saturated mode for analog FM transmission. This means that the amplifier has to be adjusted for digital operation by backing off the power, typically 3 dB, which can be readily achieved by the addition of an attenuator and switch in dual operation transmitters.

The following pages describe the key features for the following equipment necessary for digital ENG transmission: integrated encoder and modulator, encoder, modulator, transmitter, receiver, demodulators, decoder.

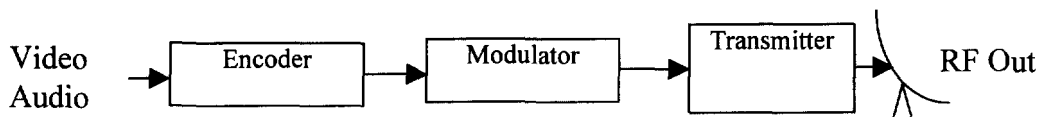
Digital ENG Transmission System Configuration

The video and audio signals are digitized, compressed, multiplexed, coded, and then digitally modulated. Error correction coding and modulation transform the digital baseband bitstream to an IF signal. The IF signal is upconverted and amplified by the transmitter to the appropriate carrier frequency for transmission.

The two basic **transmit** configurations are:



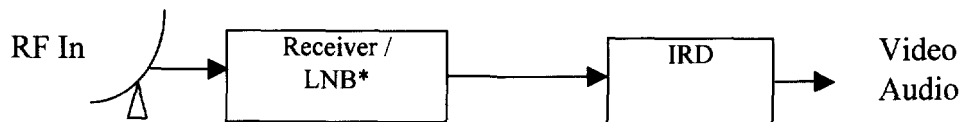
Configuration #1



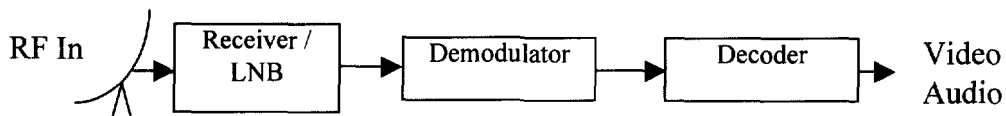
Configuration #2

The RF signal is received by an antenna and low noise block converter (LNB) that converts the RF signal to an IF signal for demodulation and decoding.

The two basic **receive** configurations are:



Configuration #1



Configuration #2

*May not be necessary if the IRD supports the full 2 GHz frequency range (2025 –2110 MHz) and has sufficient AGC.

Type of Digital Equipment: Integrated Encoder & QPSK Modulator

Manufacturer	Model	Key Features
Tiernan	TE300	Video processing: MPEG-2 MP@ML, up to 10 Mbps; Audio processing: MPEG-2 layer I & II; Internal DVB compliant QPSK modulator available (TMOD-1000)
Wegener	DVT2000 / DTV2001	Video processing: MPEG-2 MP@ML, up to 15 Mbps; Audio processing: MPEG-2 layer I & II; Integrated QPSK modulator; FEC: convolutional inner code, RS outer code; can be upgraded to MPEG-2 4:2:2
NDS	DSNG	Video processing: switchable MPEG-2 MP@ML, up to 15 Mbps and 4:2:2 SP@ML; Audio processing: MPEG-2 layer I & II; RAS scrambling; Integral IRD feature; Integrated QPSK modulator; DVB compliant FEC; IF output: 70 MHz, 140 MHz; optional 8-PSK modulator
Sony	SX	Video processing: MPEG-2 4:2:2 SP@ML, 21 Mbps; 2X real-time transmission; 2 channel transmission; 2 component video codec avail; encoders & decoders addressable

Type of Digital Equipment: Encoder

Manufacturer	Model	Key Features
Divicom	MV10 SCPC	Video processing: MPEG-2 MP@ML, up to 15 Mbps; Audio processing: MPEG-2 layer I & II; Video input: Serial digital component, analog composite; Output: DVB ASI or Divicom M2S formats on redundant 75 ohm BNCs.
Divicom	MV40	MPEG-2 MP@ML 4:2:0 / SP@ML 4:2:2 switchable encoder; 1 rack unit
Tiernan	TE30	Video processing: MPEG-2 MP@ML, up to 15 Mbps; Audio processing: MPEG-2 layer I & II; Video input: Serial digital component, analog composite; Output: Proprietary transport stream or MPEG-2 SCPC DVB transport stream (w/ TTM-2000 option module)
Tiernan	TE6	Video processing: MPEG-2 4:2:2 SP@ML, up to

		50 Mbps; VBI Processing: lossless compression on all VBI data types including Closed Caption, EBU3217, VITC, NABTS, Teletext, standard test patterns; Output: MPEG-2 DVB Transport Stream with peak output rate of 70 Mbps
Scientific Atlanta	PowerVu D9810	Video processing: MPEG-2 MP@ML and SP@ML; Video input: serial digital component, analog composite; Transport data rates: up to 15 Mbps in the 4:2:0 mode; Transport data rates: up to 45 Mbps in the 4:2:2 mode; Audio processing: MPEG-2 Layer I and II; Audio input: digital audio (AES/EBU); Optional conditional access
Tadiran Scopus	CODICO E-110	Video processing: MPEG-2 MP@ML, up to 15 Mbps; Video input: serial digital component, analog composite; Audio processing: MPEG-2 Layer I and II; Audio input: digital audio (AES/EBU); Output: RS-422; Available in 4 versions: (1) Studio grade encoder incorporating adaptive field frame processing, (2) Broadcast Grade Encoder utilizing frame-based encoding, (3) Entertainment Grade, (4) Instructional Grade
Philips	Ezcast 3150 / Ezcast 3151	Video processing: MPEG-2 MP@ML, up to 15 Mbps; Video input: serial digital component, analog composite; Audio processing: MPEG-2 Layer I and II; Audio input: digital audio (AES/EBU); Output: DVB ASI; EZ3151 offers CryptoWorks Conditional Access and DVB compliant scrambling for content protection; Encoding delay (standard mode): 284 ms, (interview mode): 154 ms
Thomson	ETSI Digithom 8522	Video processing: 4:2:2 encoding of I,P pictures; Video input: serial digital component, analog composite; Data rates: 34 and 45 Mbps (and 22, 17, 8 Mbps as proprietary equipment); Processing time: 80 msec at 34 Mbps
Thomson	MPEG-2 DBE-2110	Video processing: MPEG-2 MP@ML; Video input: serial digital component, analog composite; Audio processing: MPEG-2 Layer I and II; Audio input: digital audio (AES/EBU); Data rates: 1.5 to 15 Mbps
Thomson	MPEG-2 DBE-4110	Video processing: switchable MPEG-2 MP@ML and 4:2:2 SP@ML; Video input: serial digital component, analog composite; Audio processing: MPEG-2 Layer I and II; Audio input: digital

		audio (AES/EBU)
Leitch	-	Video processing: MPEG-2 MP@ML and MPEG-2 4:2:2 SP@ML; Video input: serial digital component, analog composite; Audio processing: MPEG-2 Layer I and II, AC-3; Audio input: digital audio (AES/EBU); Data rates: 2 to 45 Mbps; Output network interface: choice of ATM/DS-3, ATM/E3, or ASI/DVB

Type of Digital Equipment: Modulator

Manufacturer	Model	Key Features
Tiernan	TVRM75	Data interface: RS-422/530; Supports MCPC and SCPC digital TV; Variable data rate: 1.5 to 60 Mbps; Symbol rate: 37.5 Msps max; QPSK modulation; Forward Error Correction Encoding: Convolutional Inner Code K=7, (171, 133) Rate: $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{5}{6}$, $\frac{7}{8}$; Reed Solomon Outer Code (204, 188, T=8) Interleaving: Convolutional, I=12; Data scrambling: Per ETS 300 421; Optional 8-PSK modulation
Scientific Atlanta	PowerVU D9380	QPSK modulation; MPEG-2 / DVB Compatible 70 MHz or 140 MHz IF output; Selectable symbol rates from 1 to 31 Msymbols/sec; Usable information rates from 0.93 Mbps to 50 Mbps; Programmable Viterbi FEC rates of $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{5}{6}$, and $\frac{7}{8}$; Outer Reed Solomon, T=8; Trans. Rate: 2 to 62 Mbps; Output Level: -5 to -25 dBm
Raydyne	DVB3030	QPSK modulation; MPEG-2 / DVB Compatible 50 - 90 MHz IF output; Variable symbol rates from 1 to 30 Msymbols/sec; Information rates from 1 to 50 Mbps; Viterbi (K=7) rates of $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{5}{6}$, and $\frac{7}{8}$; Reed-Solomon Outer Coding; RS-422 Output; Trans. Rate: 1 to 52 Mbps; Output Level: +5 to -20 dBm; 8-PSK option
EF Data	SDM2020	Transmission rate: 1 to 100 Mbps; Symbol rate: 1 to 37.5 Msymbols/sec; DVB QPSK modulation Viterbi (K=7) FEC rates at $\frac{1}{2}$, $\frac{2}{3}$, $\frac{5}{6}$, $\frac{3}{4}$, and $\frac{7}{8}$; Reed-Solomon Outer Coding (204, 188, T=8) Interface: RS-422, PECL, ECL, DVB-LVDS, and ASI; IF Range: 50 - 180 MHz; Output Power: -20 to +5 dBm; Options: 8 PSK, $\frac{5}{6}$ and $\frac{2}{3}$

Thomson	DBM 2321	Usable data rate: 2 to 10 Mbps; Symbol rate: 1.5 to 6 MSPS; DVB compliant QPSK modulation; 70 MHz IF output; Viterbi (K=7) FEC rates at 1/2, 2/3, 5/6, 3/4, and 7/8; Reed-Solomon Outer Coding(188, 204);Output Level: -26 to 0 dBm
Philips	DVS3545/1	MCPC symbol rate: 1 - 45 MSPS; SCPC symbol rate: 1.5 - 10 MSPS; DVB compliant QPSK modulation; IF output: 50 - 180 MHz; Viterbi (K=7) FEC rates at 1/2, 2/3, 5/6, 3/4, and 7/8 Reed-Solomon Outer Coding; Options: 8-PSK,16-QAM modulation
Newtec	NTC/2059/ XL	SCPC symbol rate: 1.5 to 10.5 MSPS; DVB compliant QPSK modulation; FEC rates at 1/2, 2/3, 5/6, 3/4, and 7/8; Reed-Solomon Outer Coding; Options: 8-PSK,FEC rates at 2/3, 5/6, and 8/9
California Microwave / MRC	FS8-M	4-FSK modulator; 8 Mbps fixed bit rate; compatible with MRC's existing TBT-2 transmitter; available in approximately 3 months.

Type of Microwave Equipment: ENG Transmitter

Manufacturer	Model	Key Features
California Microwave / Microwave Radio Communications	TBT-2	Digital or analog video transmission; Millenium TBT series transmitters available in bands from 1.7 to 15.2 GHz; switchable power output: 4W/1W at 2 & 7 GHz; switchable inputs: baseband, composite video, 70 MHz IF (optional)
Nucomm	MMPT6 / PT6	Dual mode digital – analog ENG/OB transmitter system; single coax or triax cable connects control unit to RF head, up to 4 audio channels available; analog modulator, expandable to include digital modulator; controllable through front panel display or RS232; 1 RU size; control signals through mast mounted interface box.
Continental Microwave / RF Technology	UCL Series UCL-20	Digital or analog video transmission; Frequency range: 1.7 to 2.4 GHz; Input: 70 MHz IF signal Dual Upconversion; RF output: 3 Watt typical; RF channels: Field selectable channels in 100 KHz steps across 500 MHz; Heads and controls may be independently equipment: video, 2 – 34

		Mbps or both; Options: Digital Modulator
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Type of Microwave Equipment: ENG Receiver

Manufacturer	Model	Key Features
Nucomm	BDC-2-1	The BDC-2-1 supports agile tuning; Includes Low Noise Amplifier, bandpass filter, and frequency converter; currently under development
Wegener	Loop Test Translator	70 MHz input, L-band output (950 to 2050 MHz); Low Phase Noise; Digital Video Ready; Synthesized Frequency Control in 10 MHz increments
Continental Microwave / RF Technology	UCL Series UCL-20	Frequency range: 1.7 to 2.4 GHz; Output: 70 MHz IF signal; Dual Down conversion; RF channels: Field selectable channels in 100 KHz steps across 500 MHz; Includes low noise amplifier; full feature '1 box'; dynamic range: -60 to -112 dBw terminals; noise figure: 3 dB nominal
California Microwave / MRC	TBR-2	Triband portable microwave receiver, up to 3 bands from 2 – 15 GHz; switchable IF filter bandwidth; field-programmable synthesized audio subcarrier demodulators; low power consumption; L.O. Stability: 0.002% at 2 GHz; audible RCL tone aids in antenna alignment; switchable de-emphasis; video invert switch

Type of Microwave Equipment: Central ENG Receiver

Manufacturer	Model	Key Features
California Microwave / Microwave Radio Communications	MCR	Superheterodyne, dual conversion type receiver; remote control capability, low noise pre-amplifier standard, selectable IF bandwidths; optional SAW IF filter; filtered and composite video outputs, 70 MHz IF output; 2 audio channels standard; 4 audios optional
Nucomm	CR6	Agile tuning with full function remote control interface; Includes LNA, LNB, bandpass filter; Currently under development.
Continental Microwave / RF Technology	UCL Series CR	Dual terminal in 2 RU x 19 inch shelf; RS422 interface for remote tuning / control / monitoring; Digital or analog video modulation; Frequency range: 1.7 to 3.5 GHz; Input: 70 MHz IF signal

		Dual Upconversion; RF output: 3 Watt typical; RF channels: Field selectable channels in 100 KHz steps across 500 MHz; Options: Digital Modulator
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Type of Digital Equipment: IRD

Manufacturer	Model	Key Features
Tiernan	TDR600	L-band input: 950 – 2150 MHz; Input power level –25 dBm to –65 dBm; DVB-compliant QPSK signal at variable rates up to 30 MSPS; DVB-compliant FEC decoding, de-interleaving, descrambling; Video processing: MPEG-2 4:2:0 <u>MP@ML</u> & 4:2:2 <u>SP@ML</u> ; Video output: Composite analog NTSC/PAL, Serial digital component video (D1); Audio processing: MPEG-2 layer I and II audio; Audio output: Two balanced analog stereo pairs, Two AES / EBU digital stereo pairs; Data output: Two data outputs independently configurable, up to 4.096 Mbps (synchronous), 34.8 kbps (asynchronous) max.
Tiernan	TDR7/S	L-band input: 950 – 2050 MHz; Input power level –35 dBm to –75 dBm; Variable QPSK signal rate up to 60 Mbps; DVB-compliant FEC decoding, de-interleaving, descrambling; Video processing: MPEG-2 <u>MP@ML</u> , compressed video rates from 1 Mbps to 15 Mbps; Video output: Composite analog NTSC/PAL; Audio processing: MPEG-2 layer I or II audio; Audio output: Two analog stereo pair or four independent mono channels; Data output: Two data outputs, up to 4.096 Mbps (synchronous), 34.8 kbps (asynchronous) max.
Wegener	DVR2000 / DVR2001	L-band input: 950 – 2050 MHz; Input power level: -35 to –65 dBm; DVB-compliant QPSK signal; DVB-compliant FEC decoding, de-interleaving, descrambling, and Eb/No performance; Video Processing: MPEG-2 <u>MP@ML</u> ; Video output: Composite analog NTSC/PAL, S-Video, Serial digital component video (D1), supports 2.5 – 45 Mbps digital video in SCPC and MCPC modes; Audio processing: MPEG-2 layer I and II audio; Audio output: Two

		balanced analog stereo pairs, Two AES / EBU digital stereo pairs
NDS	DSNG	L-band input; DVB-compliant QPSK signal; Video processing: MPEG-2 main profile @ main level and studio profile @ main level switchable; Video output: Composite analog NTSC/PAL, Serial digital component video (D1); Audio processing: MPEG-2 layer I and II audio; Audio output: Two balanced analog stereo pairs, Two AES / EBU digital stereo pairs; 8-PSK demodulation optional
Scientific Atlanta	PowerVu D9223	L-band input: 950 – 2050 MHz; Input power level: -30 dBm to -65 dBm; DVB-compliant QPSK signal; Video processing: MPEG-2 <u>MP@ML</u> ; Video output: Composite analog NTSC/PAL; Audio processing: MPEG-2 layer I and II audio; Audio output: Two stereo pairs or four mono channels; Symbol rate range: 3 to 30.8 MSPS; Options: Audio: Additional two stereo pairs or four mono channels, digital audio output (AES/EBU); Video: Serial digital component video output (D1); Data output: 9.6 kbps to 2 Mbps via RS422
General Instruments (previously NextLevel)	DSR-4000	L-band input: 950 – 1550 MHz (2150 MHz optional); Input power level: -25 dBm to -65 dBm; Symbol rates: 3.25 to 29.3 MSPS; Supports 4 to 36 MHz bandwidths; Video processing: MPEG-2 <u>MP@ML</u> ; Video output: Composite analog NTSC/PAL; Audio processing: MPEG-2 layer I and II audio, Dolby AC-3; Audio output: Two balanced analog stereo pairs; Data output: 9 Mbps high speed channel
Tadiran Scopus	CODICO 250	L-band input: 950 – 2150 MHz; Input power level: -25 dBm to -65 dBm; QPSK modulation; Video processing: MPEG-2 <u>MP@ML</u> ; Video output: Composite analog NTSC/PAL, Serial digital component video (D1); Audio processing: MPEG-2 layer I and II audio; Audio output: One stereo pair or dual mono channels; Data output: Up to 38.4 kbps low speed data rate, Up to 8 mbps high speed data rate; Symbol rate: 2 to 30 Msps Viterbi decoding rates: $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{6}$, $\frac{7}{8}$, $\frac{8}{9}$; Reed Solomon (204, 188, 8)
Thomson	DBD2421	L-band input: 950 – 2150 MHz; QPSK

		modulation; Video processing: MPEG-2 MP@ML; Video output: Composite analog NTSC/PAL, Serial digital component video (D1); Audio processing: MPEG-2 layer I and II audio; Audio output: Two stereo pairs, up to four channels; Data output: One channel at 76,800 baud (RS-422); Useful bit rate: 1.5 to 46 Mbps; Bandwidth: 2 to 18 MHz – 27 or 36 MHz; Inner FEC Convolution Code Rates: $\frac{1}{2}$ – $\frac{7}{8}$, Reed Solomon (204, 188, 8)
Thomson	MSU4422	Similar to DBD2421; Also includes MPEG-2 4:2:2 SP @ ML video processing
Philips	IRD	L-band Input: 950 – 2150 MHz; QPSK Modulation; SCPC symbol rate: 4 – 8 Mbaud; MCPC symbol rate: 15 – 30 Mbaud; Video processing: MPEG-2 MP@ML; Video output: Composite analog NTSC/PAL; Video decoder bit rate: 2 – 15 Mbps; Audio processing: MPEG-2 layer I and II audio; Audio output: One analog stereo pair, One AES / EBU digital stereo pair; Audio decoder bit rate: 32 – 384 kbps; Viterbi decoding rates: $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{5}{6}$, $\frac{7}{8}$; Reed Solomon (204, 188, 8)
Sony	SX	This integrated receiver unit will only interface with the accompanying Sony SX transmit equipment; “Contribution picture quality” MPEG-2 SP@ML; 2 X real-time transmission; 2 channel transmission; 2 component video codec available; Encoders and decoders addressable

Type of Digital Equipment: Demodulator

Manufacturer	Model	Key Features
EF Data	SDM2020	Transmission rate: 1 to 100 Mbps; Symbol rate: 1 to 37.5 MSPS; DVB QPSK modulation; Viterbi (K=7) FEC rates at $\frac{1}{2}$, $\frac{2}{3}$, $\frac{5}{6}$, $\frac{3}{4}$, and $\frac{7}{8}$; Reed-Solomon Outer Coding (204, 188, T=8); Interface: RS-422, PECL, ECL, DVB-LVDS, and ASI; IF Range: 50 – 180 MHz; Output power: -20 to +5 dBm; Options: 8 PSK, $\frac{5}{6}$ and $\frac{2}{3}$
Newtec	NTC/2060/AA	SCPC symbol rate: 1.5 to 10.5 MSPS; DVB compliant QPSK modulation; FEC rates at $\frac{1}{2}$,

		2/3, 5/6, 3/4, and 7/8; Reed-Solomon Outer Coding; Options: 8-PSK, FEC rates at 2/3, 5/6, and 8/9
California Microwave / MRC	FS8-D	4-FSK demodulator; 8 Mbps fixed data rate; works with MRC's existing MCR central receiver and TBR-2 receiver; available in approx. 3 months

Type of Digital Equipment: Decoder

Manufacturer	Model	Key Features
Tadiran Scopus	CODICO CG-241	Video processing: MPEG-2 MP@ML, up to 15 Mbps; Video output: Composite analog NTSC/PAL on BNC connector, Serial digital component video (D1) on a BNC connector; Audio processing: MPEG-2 layer I and II audio; Audio output: Two balanced analog stereo pairs - DB-9 connectors (male), Two AES / EBU digital stereo pairs - DB-9 connectors (male); Data output: Two data outputs independently configurable, up to 2.048 Mbps RS-422 synchronous data - DB-15 HD connector; Symbol rate: 2 - 30 Msps; Viterbi decoding rates: 1/2, 2/3, 3/4, 4/5, 5/6, 7/8, 8/9; Reed Solomon (204, 188, 8)
Thomson	Digithom 8523	ETSI decoder; Input data rates: 8.448, 16.896, 22.912, 34.368, or 44.736 Mbps (G.703); Video output: Composite analog NTSC/PAL on BNC connector, Serial digital component video (D1) on a BNC connector; Audio processing: MPEG-2 layer I and II audio; Audio output: Two balanced analog stereo pairs - DB-9 connectors (male), Two AES / EBU digital stereo pairs - DB-9 connectors (male)
Leitch	-	Video processing: MPEG-2 MP@ML, up to 15 Mbps; Video output: Composite analog NTSC/PAL on BNC connector, Serial digital component video (D1) on a BNC connector; Audio processing: MPEG-2 layer I and II audio; Audio output: Two balanced analog stereo pairs - DB-9 connectors (male), Two AES / EBU digital stereo pairs - DB-9 connectors (male); Data output: 2 data outputs independently configurable,

		up to 2.048 Mbps RS-422 synchronous data - DB-15 HD connector; Symbol rate: 2 - 30 MSPS; Viterbi decoding rates: 1/2, 2/3, 3/4, 4/5, 5/6, 7/8, 8/9; Reed Solomon (204, 188, 8)
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